

Claims

- [c1] A semiconductor device comprising:
a substrate;
a dielectric layer atop the substrate, the dielectric layer including a first sub-layer, a second sub-layer and a first non-discrete transitional sub-layer residing between the first and second sub-layer, wherein the first sub-layer has an etch resistance different than the second sub-layer; and
an opening extending no deeper than the sub-layer nearest the substrate.
- [c2] The semiconductor device according to claim 1, wherein an etch resistance of the first sub-layer is greater than an etch resistance of the second sub-layer.
- [c3] The semiconductor device according to claim 1, wherein the first sub-layer has a greater content of at least one of carbon and fluorine than the second sub-layer.
- [c4] The semiconductor device according to claim 1, wherein the first sub-layer includes at least one component not included in the second sub-layer, the at least one component being selected from a group consisting of fluo-

roalkylsilanes, fluoralkylsiloxanes, perfluoroalkylsilanes, perfluoroalkylsiloxanes, alkylsilanes, and alkylsiloxanes.

- [c5] The semiconductor device according to claim 4, wherein the at least one component is selected from a group consisting of methylsilane, dimethylsilane, trimethylsilane, trifluoromethylsilane, 1,2-disilanotetrafluorethylene, 1,3-bis(silanodifluoromethylene)disiloxane, 2,2-disilanohexafluorosilane, bis(trifluoromethyldisiloxanyl)difluoromethane, octamethylcyclotetrasiloxane, and tetramethylcyclotetrasiloxane.
- [c6] The semiconductor device according to claim 1, wherein the dielectric layer includes a third sub-layer residing between the substrate and the first sub-layer and a second non-discrete transitional sub-layer residing between the third sub-layer and the first sub-layer.
- [c7] The semiconductor device according to claim 6, wherein the second sub-layer and the third sub-layer have substantially the same etch resistance.
- [c8] A method of modifying a dielectric layer during deposition, the method comprising the steps of:
continuously depositing a dielectric layer onto a sub-

strate; and

modifying at least one of a dielectric layer composition and a deposition condition during the depositing step.

- [c9] The method of claim 8, wherein the modifying step includes removing at least one component of the dielectric layer composition, the component selected from a group consisting of fluoroalkylsilanes, fluoralkylsiloxanes, perfluoroalkylsilanes, perfluoroalkylsiloxanes, alkylsilanes, and alkylsiloxanes.
- [c10] The method of claim 9, wherein the at least one component is selected from a group consisting of methylsilane, dimethylsilane, trimethylsilane, trifluoromethylsilane, 1,2-disilanotetrafluorethylene, 1,3-bis(silanodifluoromethylene)disiloxane, 2,2-disilanohexafluorosilane, bis(trifluoromethylidisiloxanyl)difluormethane, octamethylcyclotetrasiloxane, and tetramethylcyclotetrasiloxane.
- [c11] The method of claim 8, wherein the modifying step is temporary.
- [c12] The method of claim 11, wherein the modifying step includes adding at least one component to the dielectric layer composition, the component selected from a group

consisting of fluoroalkylsilanes, fluoralkylsiloxanes, perfluoroalkylsilanes, perfluoroalkylsiloxanes, alkylsilanes, and alkylsiloxanes.

- [c13] The method of claim 12, wherein the at least one component is selected from a group consisting of methylsilane, dimethylsilane, trimethylsilane, trifluoromethylsilane, 1,2-disilanotetrafluorethylene, 1,3-bis(silanodifluoromethylene)disiloxane, 2,2-disilanohexafluorosilane, bis(trifluoromethylidisiloxanyl)difluormethane, octamethylcyclotetrasiloxane, and tetramethylcyclotetrasiloxane.
- [c14] The method of claim 8, wherein the deposition condition includes at least one of temperature, pressure, flow rate of dielectric layer components, and plasma power.
- [c15] The method of claim 8, wherein the modifying step decreases at least one of the carbon content and fluorine content of the dielectric layer.
- [c16] The method of claim 8, wherein the modifying step increases at least one of the carbon content and the fluorine content of the dielectric layer.
- [c17] A method of forming at least one opening in a dielectric layer, the method comprising the steps of:

continuously depositing a dielectric layer onto a substrate;
modifying at least one of a dielectric layer composition and a deposition condition; and
forming an opening in the dielectric layer.

[c18] The method of claim 17, wherein the modifying step is temporary.

[c19] The method of claim 17, wherein the opening extends to the substrate.

[c20] The method of claim 17, wherein the opening extends to a depth not greater than a depth at which the at least one of the dielectric layer composition and the deposition condition were not modified.